〔目的〕

Several areas in Vietnam are contaminated by dioxins including 2,3,7,8 - polychlorinated dibenzo-p-dioxins (TCDD) and the toxic equivalent of polychlorinated dibenzodioxins and polychlorinated dibenzofurans (TEQ-PCDD/Fs). In our previous study reported that infants and children in the dioxin-contaminated areas showed lower neurodevelopment that was associated with increased perinatal exposure to TCDD and TEQ-PCDD/Fs. These results suggest that maternal dioxin exposure might affect the development of the fetal brain during pregnancy leading to adverse health effects on neurodevelopment in later life. On the other hand, previous studies suggest that neonatal EEG data on the first few days after birth mainly reflects intra-uterine development, and that neonatal EEG measurements during sleep may predict lower neurodevelopment status in early childhood.

In this study, to investigate effects of maternal dioxin exposure on fetal brain development and following neurodevelopment, I recorded neonatal EEGs and analyzed the relationships between dioxins (TCDD and TEQ-PCDD/Fs) in maternal breast milk and EEG power and coherence. Then, I followed up these neonates for 2 years and analyzed associations between neonatal EEG parameters with neurodevelopmental scores at 2 years of age.

〔方法〕

A total of 54 newborns with mothers from dioxin-contaminated areas were recruited in Vietnam. Dioxins in maternal breast milk collected 1 month after birth were used as a maternal exposure marker. Relative powers and coherence between electrodes were computed from neonatal electroencephalography (EEG) records during active sleep. Relationships between the EEG parameters and dioxin levels in breast milks were analyzed using a linear regression model and general linear model after adjusting for gestational weeks, body length, and head circumference of infants at birth.

Furthermore, using the data from 47 infants whose neurodevelopment was examined in a 2-year follow-up study using the Bayley Scales of Infant and Toddler Development, Ver. 3 (Bayley III), associations between EEG parameters and neurodevelopment were analyzed after adjusting for confounding factors.

〔成績〕

In the right frontal and parietal regions, relative delta powers were significantly decreased, and relative alpha and beta powers were significantly increased with increasing dioxin exposure. Increases in delta power and decreases in alpha power in the right frontal and parietal regions were significantly associated with an increase in Bayley language scores at 2 years of age. Furthermore, intra- and inter-hemispheric coherence in theta and alpha bands were positively and inversely correlated with dioxin exposure, respectively, and increased intra-coherence in the right hemisphere was associated with lower language scores.

〔総括〕

Dioxin exposure altered neuronal oscillatory activity in newborns; decreased relative delta power and increased relative alpha and beta power in the right hemisphere, which was associated with their Bayley language scores at 2 years of age. It is suggested that delta power during sleep reflects synaptic density, while dioxin exposure decreases dendritic growth. These findings suggest that prenatal dioxin exposure might reduce synaptic density in the fetal brain due to decreased dendritic growth, which in turn might lead to decreased relative delta power as well as decreased neurodevelopment.

Furthermore, dioxin exposure decreased inter-hemispheric theta coherence, while it increased intra-hemispheric theta and alpha coherence that was inversely correlated with Baley language scores at 2 years of age. It is reported that neonates with lower inter-hemispheric coherence showed language development at two years of age. Furthermore, animal experimental studies reported that dioxins reduced axonal growth or alter neuronal signal transduction pathway involved in axon guidance. These findings suggest that dioxins might reduce growth of axons connecting inter-hemispheric regions, which might result in an increase in intra-hemispheric synaptic connection, as indicated by increased intra-hemispheric and decreased inter-hemispheric coherence due to dioxin exposure leading to poor language development.

Taken together, prenatal dioxin exposure influences fetal brain development, as indicated by neonatal EEG relative powers and coherence, which may lead to poor neurodevelopment in early childhood.